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Marine Archaeological Survey at the Texas Park and Wildlife Department's Towhead Reef Site, Aransas Bay, Aransas County, Texas

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Lead Agency:
United States Army Corps of Engineers, Galveston District

Texas Antiquities Code Permit No. 9513

Prepared for:
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Prepared by:
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20-80002.001

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ABSTRACT

Under contract to the Texas Parks and Wildlife Department, Gray & Pape, Inc., of Houston, Texas, conducted a Phase I marine archaeological survey for the Texas Parks and Wildlife Department's Towhead Reef Project in Aransas Bay, Aransas County, Texas. The archaeological survey was sponsored by the Texas Parks and Wildlife Department. The Area of Potential Effect for the proposed Towhead Reef Project is a 74.9-hectare (185-acre) submerged, rectangular tract within Aransas Bay. Work was completed under Texas Antiquities Permit Number 9513. The United States Army Corps of Engineers, Galveston District has been identified as the lead federal agency, and the conduct of the project meets the requirements contained in Section 106 of the National Historic Preservation Act of 1966, as amended, the regulations of the Advisory Council of Historic Preservation (30 CFR Part 800), the National Environmental Policy Act of 1969, as amended. All marine fieldwork and reporting activities were completed with reference to state law (Antiquities Code of Texas [Title 9, Chapter 191 of the Texas Natural Resources Code] and Texas State rules found in the Texas Administrative Code [Title 13, part 2, Chapters 26 and 28]) for cultural resources investigations. All project records are curated at the Texas Parks and Wildlife Department in Austin, Texas.

The Texas Parks and Wildlife Department's proposed project is designed for oyster reef restoration and requires a survey of the bay bottom to determine existing hazards/obstructions, generally characterize the substrate type, and document any magnetic anomalies that could represent historic shipwrecks for avoidance during the proposed undertaking. Oyster reef habitat will be restored by placing approved cultch material on the bay floor in historical oyster reef areas in mounds or in a uniform layer. The Phase I underwater archaeological investigation assessed the number, locations, cultural affiliations, components, spatial distribution, data potential, and other salient characteristics of potential submerged cultural resources within the proposed reefing project area.

The marine field investigations of the Towhead Reef Project survey area consisted of a magnetometer and side-scan sonar investigation of the Area of Potential Effect in safely navigable waters on August 4, 2020; the survey was conducted in a total of 24-person hours. The comprehensive analysis of the magnetic data recorded resulted in the identification of a total of 52 magnetic anomalies, of which one (Anomaly No. 1) is interpreted as a potential cultural resource (i.e. historic shipwrecks). The remaining magnetic anomalies are interpreted as modern debris associated with recreational and commercial fishing activities, miscellaneous debris from previous tropical storms, existing pipelines, and an abandoned gas well, and as such do not represent significant cultural resources. Side-scan sonar imagery did not indicate any potentially significant cultural material laying above or on the bay bed within the survey area. Sonar data did record a probable drag or trench scar extending across the project area, with associated magnetic anomalies. The recommended management action for the Towhead Area of Potential Effect is avoidance of bottom disturbance activities within the 50-meter (164-foot) avoidance areas, as mandated by Texas Administrative Code, Title 13, Part 2, Chapter 26, for magnetic Anomaly No. 1. If avoidance is not possible, then Gray & Pape, Inc. recommends archaeological diver-ground truthing to identify and evaluate the potential for National Register of Historic Places significance of the anomaly.

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1.0 INTRODUCTION

Gray & Pape, Inc. (Gray & Pape), of Houston, Texas, in conjunction with BIO-WEST. Inc. (BIO-WEST), also of Houston, conducted a Phase I marine cultural resources survey for the Texas Parks and Wildlife Department's (TPWD's) Towhead Reef Project in Aransas Bay, Aransas County, Texas (Figure 1-1). The Texas Parks and Wildlife Department plans to create a new shallow artificial reef for oyster restoration and requires survey of the bay bottom to determine existing hazards/obstructions, characterize the substrate type, and document any magnetic anomalies that could represent historic shipwrecks for avoidance during the oyster reef project.

The submerged land for the Towhead Reef Area of Potential Effect (APE) is in State Tract numbers administered by the Texas General Land Office (TxGLO), an agency of the State of Texas created to manage the public domain. As such, the Antiquities Code of Texas (Texas Natural Resource Code, Title 9, Chapter 191) applies. Marine fieldwork and reporting activities were completed with reference to state standards (Antiquities Code of Texas [Title 9, Chapter 191 of the Texas Natural Resources Code] and Texas State Guidelines found in the Texas Administrative Code [Title 13, Part 2, Chapters 26 and 28]) for cultural resources investigations. Work was completed under Texas Antiquities Permit Number 9513 issued by the Texas Historical Commission (THC) on July 23, 2020. As the project is within the navigable waters of the United States, the United States Army Corps of Engineers (USACE) has been identified as the lead federal agency, and the conduct of the project meets requirements under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the regulations of the Advisory Council of Historic Preservation (30 CFR Part 800), and the National Environmental Policy Act of 1969, as amended.

1.1 Project Overview

The project area is located along the Texas Gulf Coast. The Towhead Reef plot is a 74.9-hectare (185-acre) rectangular tract within Aransas Bay. The APE is located on the *St. Charles Bay SW, Texas* 7.5-minute United States Geological Survey (USGS) topographic quadrangle map (Figure 1-1). Current depths in the project area are in the approximate range of 0.6 to 1.8 meters (2 to 6 feet), according to the National Oceanic and Atmospheric Administration (NOAA) nautical chart # 11314 entitled *Carlos Bay to Redfish Bay including Copano Bay* (NOAA 2020a). The actual water depths recorded at the survey area ranged from 0.6 to 1.8 meters (2 to 6 feet).

The Towhead Reef project area was selected by TPWD because it is the site of a naturally occurring oyster reef that has degraded over time. Oyster reef habitat will be restored by placing approved cultch material on the bay floor in historical oyster reef areas in mounds or in a uniform layer. The areas chosen must have a bottom firm enough to support materials. The cultch may be laid in either a uniform layer or in mounds. Cultch spread in a uniform fashion will range from 0.91 meters (3 feet) to 1.21 meters (4 feet) in depth. Mounded cultch material will be laid in a diameter not to exceed 3 meters (10 feet) in diameter and no taller than 0.6 meters (2 feet) high. It is important to note that mounded cultch will not be a navigation hazard as mound crest will be greater than 1 meter (3 feet) from the surface of the water at Mean Lower Low Water (MLLW).

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Figure 1-1. The Towhead Reef project area location, Aransas Bay, Aransas County, Texas.

1.2 Report Organization

This report is organized into seven numbered chapters and three appendices. Chapter 1.0 provides an overview of the project. Chapter 2.0 presents an overview of the environmental setting and geomorphology of the project area. Chapter 3.0 presents a discussion of the cultural context associated with the project area. Chapter 4.0 presents the methodology developed for these investigations. The results of these investigations are presented in Chapter 5.0. Chapter 6.0 presents the investigation summary and provides recommendations based on the results of the field survey. A list of all references cited is provided in Chapter 7.0. The sonar target table is provided in Appendix A, the sonar target images are provided in Appendix B, and the table of magnetic anomalies is provided in Appendix C.

1.3 Curation

No diagnostic or non-diagnostic artifacts were collected in the course of the current survey. As a project permitted through the THC; however, Gray & Pape submitted project records to the TPWD in Austin, Texas.

1.4 Acknowledgements

The successful completion of this project was made possible by a joint effort between BIO-WEST and Gray & Pape personnel. BIO-WEST provided all equipment and watercraft necessary for the survey. Research on various aspects of this project was conducted by Project Manager Jim Hughey, M.A., RPA, Principal Investigator Amanda Evans, Ph.D., RPA, and Marine Archaeologist John Rawls, M.A., RPA. Background research included consultation of online research archives maintained by the THC, resources maintained by the Soil Service Staff of the Natural Resources Conservation Service of the United States Agriculture Department (SSS NRCS USDA), and numerous marine targets datasets.

The marine survey was conducted on August 4, 2020. The survey team included BIO-WEST's Matt Chastain, Captain Doug Williamson, and Gray & Pape's Dr. Amanda Evans. Magnetic and acoustic data analysis was conducted by Dr. Evans. John Rawls, Amanda Evans, Michael Quennoz, and Jim Hughey prepared the report. Duncan Hughey and Tony Scott produced graphics. Jessica Bludau edited and produced the report.

2.0 PHYSICAL SETTING

2.1 Physiography and Geomorphology

The present coastline of the Texas Gulf Coast has fluctuated relatively little in the past approximately 3,000 years. However, prior to 8,000 B.C., the Gulf Coast extended to the southeast. Towards the end of the Pleistocene era 20,000 years ago, global temperatures rose, and sea levels rapidly began to rise. By 8,000 B.C., shorelines worldwide had progressed inland, with the flooding of the valleys of major streams along the Texas coast, such as the Trinity, Lavaca, Guadalupe, Aransas, and Nueces Rivers (Ricklis and Weinstein 2005). As a result, the earliest forms of the modern coastal bays found in Texas were created. Aransas Bay is separated from the Gulf of Mexico by a postglacial barrier island of dunes and washover fans. Depths are greatest in the southwestern portions of the bay, approximately 4 meters (13 feet) maximum depth and shallower in the northeast, approximately 2.1 meters (7 feet) maximum depth. Freshwater inflow mostly comes from connected bays such as Copano Bay (Folger 1972).

2.2 Soils

The terrestrial environmental setting found nearest to the Towhead Reef project area consists of the Telferner-Edna soil association (s7675). It is described as a "nearly level, non-calcareous, somewhat poorly drained, and poorly drained loamy soils" on the upland coastal plain and on some high terraces of the uplands (Mowery and Bower 1978:4).

2.3 Natural Environment

2.3.1 Climate

Aransas County's proximity to the Gulf of Mexico tends to influence the temperature, rainfall, and relative humidity of the region, producing a humid subtropical climate. Winds usually trend from the southeast or east, except during winter months when high-pressure systems can bring in polar air from the north. Summers are warm and winters tend to be mild. The mean daily maximum temperature for the year is 28.2° Celsius (82.7° Fahrenheit), and the mean daily minimum temperature is 17.4° Celsius (63.3° Fahrenheit). Precipitation comes in both thunderstorms and trace amounts. Hurricanes are known in the region producing high winds and copious amounts of rain. The average annual rainfall for Aransas County is 93.5 centimeters (36.8 inches) (Guckian and Garcia 1979).

2.4 Tide

The project area is in Texas' shallow coastal bay and experiences tidal influences. During the field activities for this project, the tide at the Rockport Station (ID 8774770), the closest tide monitoring station, was reported to range from a high of 0.09 meters (0.30 feet) to a low of -0.01 meters (-0.04 feet) for a total range of 0.1 meters (0.34 feet) MLLW on August 4, 2020. The reported extreme tides for project area between July 15, 2020 and August 15, 2020 are at a high of 0.11 meters (0.35 feet) on July 31, 2020 and a low of -0.04 meters (-0.14 feet) MLLW on July 20, 2020, for a total range of 0.15 meters (0.49 feet) (NOAA 2020b). The tide, although not dramatic, does have an influence on the area surveyed.

3.0 CULTURAL CONTEXT

3.1 Prehistoric Context

3.1.1 Paleoindian Period

Evidence is sparse for Paleoindian habitation, and much of what is known about the period in the current project area comes from a compilation of materials gathered from around the state of Texas and North America. At the close of the Pleistocene, large-game hunters crossed the Bearing Strait, and within a few millennia had penetrated South America (Newcomb 1961). The Paleoindian people traveled in small bands and were mega-fauna hunter-gatherers with the bulk of their meat protein derived from mammoths, mastodons, giant bison, and giant sloths. It is believed that in south Texas, the Paleoindian people traveled in small groups of non-specialized hunters and gatherers rather than the larger groups normally associated with the big game hunters of the Great Plains (Hester 1976). These groups carried with them an easily recognizable stone tool material culture, though little is known about their wooden or bone tools or their clothing types. Diagnostic spear points such as fluted Clovis, Folsom, and Plainview points can be used to identify a site's Paleoindian component, and the nature of these points demonstrate the population's hunting style. Paleoindian-era points are large and designed to be attached to a spear. No evidence of bow and arrow hunting has been found associated with this period (Newcomb 1961).

3.1.2 Archaic Period

After the Pleistocene, the Gulf of Mexico's encroachment onto the Texas coast created estuaries along the shoreline. The formation of these estuaries provided the Archaic people of the Texas coast with a ready supply of marine food resources (Jurgens 1989). This shift in the food supply is seen as the pivotal transition point between the Paleoindian and Archaic periods in the region (Aten 1984; Newcomb 1961). Within the boundaries of the south Texas coast, the Aransas complex has been identified based on a suite of tools indicative of a lifestyle based on marine resources (Campbell 1958; Corbin 1974). Material culture recovered from Archaic sites within the south Texas region includes shell artifacts such as conch columella gouges, adzes, and awls. Stone projectile points recovered from Archaic sites in the region include Abasolo, Palmillas, Ensor, Refugio, and Tortugas types (Turner and Hester 1993).

3.1.3 Late Prehistoric

The Prehistoric period continues from the end of the Archaic period to the Historic period ushered in by the Spanish missions and Anglo-American settlers. During the Late Prehistoric stage in south Texas, two cultural complexes appear to have existed in the vicinity of the project area. The first complex was located further east on the coast and appears to have been affiliated with the Goose Creek complex, while the second complex has been called the Rockport complex (Jurgens 1989). During this period, there is a shift to the almost exclusive use of arrow points such as Perdiz and Scallorn (Turner and Hester 1993), and almost every group had pottery. It is during this period that two similar cultural groups, known today as the Coahuiltecans and the Karankawas, are identifiable both ethnographically and archaeologically.

Within south Texas, the Karankawa and Coahuiltecans extended south of Galveston Bay to the Rio Grande and as far west as present-day San Antonio. The Karankawa were located along the coast while the Coahuiltecan were inland. Most of what is known of both groups come from the time that Cabeza de Vaca spent with them as a captive and trader (Newcomb 1961).

The Coahuiltecans populated the majority of the land of present-day Aransas County. Their language group, which is related to the Hokan group of languages of California, extended from the Gulf Coast to the west, as far as present-day San Antonio (Aten 1984). The Coahuiltecans were subdivided into over two hundred small bands with four or five groups living within the south Texas region, including among them the Aranamas, Orejons, and Pachal. The Aranamas dwelled primarily between the San Antonio and Guadalupe rivers. The Orejons lived south of the Aranamas along the lower Nueces River. The Pachal group lived near the junction of the Frio and Nueces rivers and possibly even crossed the Rio Grande.

The Karankawas, whose language was also in the Hokan group (Aten 1984), extended from Galveston Bay southwest as far as the present site of Corpus Christi Bay. As described by Newcomb (1961), seven proper names are associated with the culture, but researchers subdivide these names into five distinct groups based on geography. The Capoques and the Hans lived in the area between Galveston Bay and the Brazos River. The Kohanis lived south of the Capoques and the Hans at the mouth of the Colorado River. The Karankawa proper (which included the Korenkake, Clamcoets, and Carancaguacas) lived in the region of Matagorda Bay. Along Copano Bay and St. Joseph Island, were the Kopanos (Newcomb 1961).

3.2 Historical Context

3.2.1 Aransas Bay Historical Context

The earliest European thought to have explored Aransas Bay was Alonzo Alvarez de Pineda, who sailed along the Texas Gulf Coast in 1519. A few years later, Spanish explorer Alvar Nunez Cabeza de Vaca was shipwrecked on the coast. Some historians believe that he and his crew may have crossed through Aransas County. It was not until the French established a colony under Rene Robert Cavelier, Sieur de La Salle in Texas in 1685 that the Spanish interest began to grow (Weddle 2010).

In the seventeenth and eighteenth centuries, the Spanish and French used the Native-American groups as pawns in the two nations' quest to settle the area (Newcomb 1961). Most destructive for all native groups in the region was the influx of European diseases. When Anglo-American settlers began moving into the area in mass around the 1850s, disease and warfare had brought the groups close to extinction.

By the late 1700s, a port of entry and customhouse were established in nearby Copano Bay. The port served as a landing point for hundreds of settlers, although most colonists moved further inland and the coast remained mostly unsettled until the mid-1800s (Long 2010). After Texas independence, the area became part of Refugio County. In 1832, Aransas City was founded. The Comanche and Karankawa Indians raided the town on several occasions, as did Mexican bandits.

At the same time that Aransas City was developing, the town of Lamar was established. As a result, the first president of Texas, Mirabeau Lamar, ordered the customhouse moved to Lamar and Refugio was declared the county seat. As a result, Aransas City began to decline and by 1846, was nonexistent (Long 2010). After the revolution, cattlemen and sailors developed the community of Aransas on the south end of St. Joseph's Island, a prosperous port prior to the Civil War.

During the Civil War, the area was used for many engagements between Union and Confederate troops. In 1862, a Union ship called the USS *Afton* docked at St. Joseph's Island and destroyed the town of Aransas. Despite the disruption of the area caused by the Civil War, the future Aransas County was quickly rebuilt, including the town of Lamar (Long 2010).

Due to the great success of cattle ranching in the newly established city of Rockport, the community became the new county seat of Refugio County. In 1871, legislature voted to divide Refugio County, and on September 18th, the county of modern-day Aransas was born, and Rockport became the county seat. In 1888, the San Antonio and Aransas Pass Railroad lines reached Rockport and thus cemented the city's prosperity by making it an important shipping center. A new county courthouse was built in 1889, and by 1900, the county had seven post offices and six public schools. In 1919, the area was devastated by a powerful hurricane and much of Rockport was destroyed. The first half of the twentieth century resulted in the introduction of two emerging industries, commercial fishing, and shipbuilding. By 1950, the shrimping industry produced 51 million pounds of shrimp. The shipbuilding industry flourished during World War I, with the Heldenfels Shipyard producing vessels under a military contract (Long 2010).

3.2.2 Navigational History

Although previous Spanish explorations of the Texas coast had made note of Aransas Pass, exploration of Aransas Bay itself likely didn't come until the eighteenth century. By 1766, a coast guard post had been established at "Aranzaza"; today the area is known as Live Oak Point. Regular vessel traffic began passing through Aransas Bay with the opening of El Copano on the northwestern shore of Copano Bay in the 1780s as a port and customshouse, including apparently a thriving smuggling trade (Benowitz 2010).

Passenger ships carrying immigrants during the early nineteenth century brought more respectable traffic through Aransas Bay for the port at El Copano, arriving from New Orleans and other American ports (Gulley 2015). Captain Monroe of the ship *Amos Wright* produced an early map of Aransas Bay in 1833 and in the process gave the bay its present name (Leatherwood 2010). El Copano changed hands several times during the Texas Revolution, before finally ending up under Texas control. Afterward, trade passing through the bay continued to grow. Disruption again occurred during the Civil War with Union vessels blockading the Gulf Coast. Union gunboats entered Aransas Bay in 1864, briefly anchoring off El Copano in an attempt to discourage blockade running but left a few days later (Benowitz 2010).

After the Civil War, maritime trade rebounded quickly in Aransas Bay with the growth of the meatpacking industries in Rockport and Fulton. The growth of the railroad industry and the establishment of Corpus Christi as a deep-water harbor reduced the level of large-scale maritime trade within Aransas Bay (Shukalo 2016). Fishing and recreational traffic increasingly dominated the area and in the 1940s, expansion of the Intracoastal Waterway allowed traffic to move along inland waters between the Texas Gulf bays.

NOAA's Historical Map and Chart Collection was consulted for Aransas Bay (NOAA 1858, 1884, 1917, 1934, and 1959). The earliest detailed chart dates from 1858. It shows no wrecks within the bay or developments along its shores. Plotted natural features near the APE consisting of oyster reefs/shoals including Pelican Reef and Poverty Reef. Water depths in the vicinity of the project area range from 1.98–2.43 meters (6.5–8 feet). The subsequent map from 1884 shows minimal changes and no shipwrecks. The 1917 chart does not show any changes within APE; however, the chart does show the channel, the Cape Carlos Dugout, south of the APE connecting Aransas Bay with Mesquite Bay. A review of the 1934 chart does not show any shipwrecks and water depths near the APE range from 1.5–2.4 meters (5-8 feet). The Gulf Intracoastal Waterway (GIWW) first appears in the 1959 navigation chart and is located south of the APE. The GIWW allowed vessels to navigate between the Aransas/San Antonio Bay system. Although direct historical information is limited for Aransas Bay, review of the available historical navigation charts allows the inference that it was never a primary shipping route. However, much as it is currently, the bay was likely exploited for its marine resources and by people for recreational purposes.

3.3 Maritime Context

Researching the types of watercraft ubiquitous to the region throughout history can aid in the identification and temporal association of encountered shipwrecks and vernacular watercraft within the APE. Probing historic documentation of vessel losses is another avenue to assist in identifying submerged cultural resources reportedly lost within a specific area.

Various types of watercraft have been used to ply the waters of coastal Texas and its associated rivers from the earliest prehistoric inhabitants to the modern-day local residents and commercial enterprises. Vernacular watercraft were developed, constructed, and modified for use in the shallow lakes and bayous and shoaled, snag-filled rivers throughout coastal Texas. Sea-going vessels with deeper drafts were confined within maintained navigation channels and were dependent upon smaller vessels or boats to disperse their cargoes for transport inland. All vessels throughout history, from prehistoric canoes to historic sailing vessels to steamboats have been subject to overloading, foundering, snagging, collision, and even catastrophic failure. As such, many vessels have been lost throughout the centuries in the waterways of coastal Texas. Though there are no specific watercraft that are unique to the project area, a discussion of the types of watercraft that were used in and around the project area throughout time and the requisite characteristics of each are presented below to demonstrate changes in morphology and continued trends that may be evident in the archeological record.

3.3.1 Aboriginal Watercraft

The dugout canoe, also known locally as a pirogue or piragua, is one of the earliest forms of vernacular watercraft to ply the waters of the APE. These watercrafts were utilized by the Karankawa and other indigenous groups of coastal Texas. The dugout canoe typically is a long, narrow, flat-bottomed, double-ended vessel that could be paddled or rowed. They were primarily used for transportation within the shallow waters of lagoons and inlets (Francaviglia 2010:36). The early dugout canoe was constructed by felling a tree and using fire and hand tools to burn and hollow out the log. Cypress was typically the wood of choice, though Native Americans in the region also used cottonwood (Comeaux 1985:164). The degree of variation in size of the dugout depended largely on the size of available logs and the vessel's intended function. For maneuverability and portability, the Karankawa probably restricted dugouts to a maximum length of approximately 6.1 meters (20 feet) with a beam of 0.8 meters (2.5 feet) (Francaviglia 2010:38).

While there are not any previously documented aboriginal watercraft in Aransas County, there is one archaeological example of a dugout canoe located in adjacent Calhoun County, Site 41CL51 (THC 1974). It was located in 1974 by Jack Purcell on Vanderveer Island in Espritu Santo Bay (THC 1974). It measured 6.1 meters (20 feet) in length and weighed approximately 350 pounds. Information regarding other attributes to the vessel such as wood type is not available on Texas Archeological Sites Atlas (Atlas), maintained by the THC, site form. Due to the lack of any potential magnetic components, the probability of identifying a dugout canoe buried beneath bottom sediments via remote sensing survey is not possible; however, a dugout canoe could possibly be identified in the sonar record if exposed on the seafloor but would be difficult to positively identify as a historical resource as opposed to a naturally occurring feature such as a felled tree.

3.3.2 Historic watercraft

Although there are no specific accounts of the types of vessels used in the waters of the APE during the early historic period, it is likely that historic watercraft used in Aransas Bay were similar to those used on other western rivers and coastal harbors along the Texas Coast. The most common vessels that would have navigated the shallow bays, as well as the waters surrounding the project area, include schooners, sloops, luggers, and steamboats, as well as more recent gas-powered vessels. The distinct characteristics of each are described below.

3.3.2.1 Schooners

The schooner is a type of sailing vessel whose name refers to its sail configuration and is typically a sharp-built vessel, with two masts of considerable length and rake, with a small top mast, and fore and aft sails. Schooners are usually larger than sloops due to the larger sail area required by their deeper hull, which resulted in a deeper draft. As such, these vessels were regularly used for longer voyages transporting cargoes in the coastwide trade.

Schooners can be divided and further specified according to their type of rigging, function, or region of use. Originally rigged with square topsails, early schooners were referred to as topsail schooners. Later schooners were referred to as fore-and-aft schooners due to their rigging with Bermuda sails aligned fore and aft rather than squared to the masts (Saltus 1987:68). Schooners were also built in two, three, and four-masted configurations. Even within a single category of mast configuration, schooners were highly variable in size. For example, a two-masted scow schooner had a typical size range of 7.19 to 26.82 meters (23.6 to 88 feet) in length, 3.04 to 7.46 to meters (10 to 24.5 feet) in beam, with a depth of hold ranging from 0.76 to 2.86 meters (2.5 to 9.4 feet) (Saltus 1988:90).

When defined by their function, schooner types included: pilot schooners, trading schooners, fishing schooners, and packet schooners. Those defined by hull form included: scow schooners, barge schooners, pungy schooners, file bottom schooners, and ram schooners (Saltus 1988:90). Schooners defined by region of use included: Chesapeake Bay schooners, Great Lakes schooners, and Coastal schooners (Saltus 1987:68). Saltus argued that among schooners, "the diagnostic attribute is the vessel's shallow draft and wide beam, dictated by the environment, depth, and functional need" (Saltus 1988:90).

The most common type of schooner to operate in the vicinity of the APE is the Gulf scow schooner. Its versatility allowed the schooner to operate in the open ocean, shallow bay waters, rivers, or inland lakes of southern Texas. The vessel evolved from the scow, a versatile flat-bottom sailing craft that has been used in shallow harbors and inland waters along the East Coast since the early nineteenth century. By the late nineteenth century, Gulf Coast builders developed a V-bottom scow. The V-bottom scows were framed and planked lengthwise on the bottom with deep transom at bow and stern, with the bow transom set at a great rake; and measured 9.75 (32 feet) to 15.24 meters (50 feet) long. These vessels were very popular from New Orleans westward to the Mexican border (Chapelle 1951:333–334). A typical schooner operating in coastal Texas is presented in Figure 3-1, which shows a two-masted, cargo-laden schooner in transit in Galveston Bay taken in 1910.

Figure 3-1. Photograph taken in 1910 on Galveston Bay showing a two-masted scow schooner in transit loaded with cargo (photograph courtesy: The Portal to Texas History).

A review of THC records indicates that there are a total of 14 reported schooners lost within Aransas County, none of which have been verified archaeologically. There are no schooners reported lost within or near the APE, but a low to moderate probability of discovering a historic schooner within the project area remains due to their frequency and duration of usage in the area.

3.3.2.2 Sloops

The sloop, another versatile sailing craft, can be described as a vessel with one mast like a cutter but having a jib stay, which a cutter does not. Also, sloop is the general name of ships of war below the size of frigates (Brande 1856 as presented in Saltus 1987:71). Like the schooner, sloop also refers to the vessel's sail configuration. Varieties of sloop include the sloop-of-war, ship-sloop, brig-sloop, and corvette (Saltus 1988:92). Sloops were capable of sailing in various environments including the narrow inland rivers and the open ocean.

The "Texas scow sloop," also known as the "Port Isabel sloop" and "Laguna Madre sloop" evolved to meet the unique conditions within the various and many shallow lagoons of the Texas coast (Figure 3-2). The basic form and rig consist of a gaff-rigged sloop with a single mast, with transom ends, a bit of V-bottom fore and aft, and two trunk cabins. The rigging configuration, along with a centerboard, made the Texas scow sloop very maneuverable in the variable winds of the lagoons. The vessel's shallow draft, drawing less than 0.61 meters (2 feet) of water, allowed for navigation into shallow waters in the vicinity of shoals and oyster beds.

Sloops ranged in length from 7.92 to 9.75 meters (26 to 32 feet) with beam measurements ranging from 3.04 to 3.65 meters (10 to 12) feet, and draft of 0.30 meters (1 foot), with the centerboard raised into the hull (Doran 1987:54). These vessels were constructed of local yellow pine and cypress; near the Mexican border, boat builders used mesquite knees in lieu of cypress crooks. They were built upside down using the frames and the end-transoms as molds, retained chine logs, and were cross planked on the bottom (Chapelle 1951:336). A typical Texas scow sloop operating in coastal Texas is presented in Figure 3-3 which is a historic photograph of a scow sloop in transit.

Figure 3-2. A historic photograph (date unknown) showing a Texas scow sloop underway (as presented in Chappelle 1951:175).

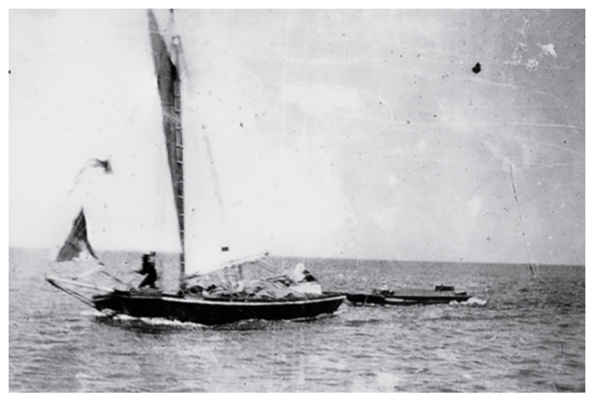

Figure 3-3. A historic photograph (date unknown) showing a Texas scow sloop underway (photograph courtesy: https://thedolphintalk.com/?p=10537).

Texas scow sloops were constructed by small-boat builders from the mid-1850s until as late as 1952 (Francaviglia 2010:247–248) and were very popular in the commercial fishing industry. These vessels would fish in pairs with gill nets extended between them which could yield thousands of pounds per netting. Paired gill-netting resulted in overfishing, and nearly decimated the fisheries in coastal Texas. In 1952, Texas banned the use of gill nets, essentially marking the end of the Texas scow sloop. A replica of a Texas scow sloop, *La Tortuga*, built in 1990, is on display at the Texas

Maritime Museum in Rockport, Texas (Figure 3-4).

A review of the Atlas database indicates that there are no reported sloops lost in Aransas County or near the APE. However, due to the prevalent use and popularity of these vessels, the potential still exists that historic sloop remains may be identified.

Figure 3-4. Photograph of *La Tortuga*, a replica Texas scow sloop (photograph courtesy: Dolphin Talk 2020).

3.3.2.3 Lugger

The early lugger, whose name is derived from the rig of Mediterranean sailing boats, had rounded hulls and used centerboards (Pearson et al. 1989:198; Comeaux 1985:172). Employed as work boats for oystering and shrimping activities, luggers operated frequently in shallow coastal lakes, bayous, and marshes as well as deeper bays. The construction of the boats was conventional, consisting of sawn frames, carvel planking, and the usual plank keel of the centerboard. The timbering and plank were often local longleaf pine and cypress (Pearson et al. 1989:198).

With the advent of the motorized lugger, older sailing luggers were surpassed in quantity and popularity. Motorized luggers, omitting the centerboard, allowed for rapid transport of fishing commodities to the market unlike the slower sailing luggers (Comeaux 1985:172). The motorized luggers included a cabin to house the engine and operating controls. Motorized luggers appear typically as flat-bottomed, small craft, generally 6 to 9 meters (20 to 30 feet) long. More seaworthy luggers, commonly 12 to 15 meters (40 to 50 feet) length, were introduced later to access offshore oyster and fishing resources (Comeaux 1985:172).

A review of the Atlas database indicates that no luggers have been identified within Aransas County or near the project area. However, due to the prevalent use and popularity of these vessels, the potential still exists that historic lugger remains may be identified.

3.3.2.4 Steamboats

Steamboats represent one of the most technologically innovative watercraft used in the nineteenth century. Propelled by steam engines, boilers, and paddlewheels, they were designated as sidewheelers or sternwheelers according to where the paddlewheel(s) was located on the vessel. Steamboats developed on the eastern rivers in the early nineteenth century but rapidly spread throughout the western rivers (Pearson et al. 1989:107).

By the 1840s and early 1850s, the western river steamboat began to take on the attributes now associated with the classic riverboat. The most significant change during this time was hull design. Rounded hulls became less preferred to rectangular, single-framed hulls with either no keel or only a vestigial keel (Pearson and Saltus 1993:15). The purpose of this design change allowed boat builders to construct a hull that could transport as much cargo as possible and at the same time draw as little water as possible to allow maneuverability with sufficient speed in shallow water, as well as to reduce listing tendencies, a feature critical to steam power operation (Tuttle et al. 2001:13). The most buoyant and stable hull was a flatboat; a long, flat bottom intersecting two short sides at right angles. Besides the stability, the cost of constructing a straight-lined hull with flat surfaces was more economically feasible than constructing one with the sheered lines of a sailing ship (Tuttle et al. 2001:13).

After the Civil War, sternwheel propulsion became preferred over sidewheel propulsion. Cheaper to construct and more effective in shallower water depths than sidewheelers, sternwheelers became the most common vessel type by 1870.

A review of the Atlas online database indicated that there are two reported steamships lost in Aransas County. The steamer *Lizzie Baron* (THC Shipwreck No. 2479) is plotted to the northwest of the project area, and southeast of Lamar, Texas. The second vessel, a steamship known as the Fire Brick Wreck (41AS117; no THC Shipwreck No. assigned), was identified just north of the Aransas Channel, shoreward of San Jose Island. The vessel was confirmed through diver investigation, and a boiler, firebox, metal spikes and rods, and a turnbuckle were documented on site. Bricks identified on site contained manufacturers marks, and dates on the bricks provide a *terminus post quem* of 1915 (THC 2020a). The site covered an area of approximately 46 to 61 meters (150 to 200 feet) long by 12 meters (40 feet) wide.

There are no reported steamboat losses reported near the project area; however, the current APE is located north and west of the maintained Cape Carlos Dugout channel (NOAA 1934). It is possible that steamships traveled within the area, and additional steamship remains may be identified within Aransas County.

3.3.3 Post-Civil War and other Modern Craft

Post-Civil War watercraft continued to utilize steam engine technology until they were gradually phased out by the invention of diesel and gasoline-powered motors. The slow-moving steamboats gave way to the towboats and barges for transporting large quantities of goods. According to Pearson et al. (1989:180), towboats and barges became the predominant mode of commercial freight transportation. Railroads, combined with motorized vessels, played a significant role in the demise of the steamboat.

3.3.3.1 Trawler

In the early twentieth century, the exploitation of shrimp as part of the seafood industry brought the motorized shrimp trawler to the fleets of vessels traveling to deeper waters in the Gulf of Mexico. Initially introduced to the region, the South Atlantic trawler, 15.24 to 19.81 meters (50 to 65 feet) in length, was modified to become the shrimp trawler, a smaller version designed to trawl the bays and nearshore waters of the Gulf Coast (Figure 3-5) (Comeaux 1985:172). Trawlers exhibit substantial forward sheer, high, flaring bows, with a nearly vertical stem, and broad, flat hulls. Larger versions, designed for deeper waters, are known as Florida-type shrimp trawlers. Trawlers are constructed of wood or steel and have been readily adopted and adapted to suit the needs of the seafood industry and the constraints of the environment. Though the deeper drafted Florida-type shrimp trawlers are found among the deepwater ports throughout the Gulf Coast, the smaller, coastally adapted trawlers can be found operating near the project area. Due to the prevalence of trawlers employed in the seafood industry in coastal Texas, there is a moderate probability of locating historic trawlers that have foundered or were abandoned within the waterways of the project area.

Modern watercraft in the coastal Texas region have continued to evolve and are used for a wide range of activities, including transportation of commodities and raw materials, pleasure craft, or participation in the seafood procurement industry throughout the project area. These vessels have typically abandoned the sailing rigging for motorized propulsion though a few old-fashioned holdouts still remain. Modern watercraft include skiffs, john boats, yachts, and trawlers. There is a moderate probability that the remains of modern watercraft may be identified.

Figure 3-5. Photograph of a trawler docked at a slip in Olivia, Texas (photograph courtesy: Gerald Massey).

3.3.4 Preservation of Submerged Cultural Resources

The natural environment and human action are the two factors that directly influence the preservation of submerged cultural resources. The nature of the marine environment can aid in the preservation of wrecks or it can initiate rapid degradation of these fragile resources. For example, changes in a river course can lead to complete burial and eventual land-locking of shipwrecks that originally were lost in riverine locations. Vessels abandoned along a riverine embankment can be filled with sediments or scoured by a high current. Storm surges from hurricanes also carry a high sediment load and are likely to bury historic shipwrecks lost within the project area under tens of feet of silt and sand forming a protective anaerobic environment. As such, there is a greater chance of preservation. However, scouring actions from storm surges also can cause dispersal of hull fragments and artifacts along the bottom or allow the hull to settle lower and lower into soft bottom. Upon settling down to hardpan, though, those portions of the vessel exposed above the seafloor remain subject to erosion.

Another environmental factor that is detrimental to the preservation of a shipwreck's wooden components and artifacts in saltwater environments is the naval shipworm (*Teredo navalis*), a species of wood consuming bivalve mollusks in the family *Teredinidae*. The bivalve is called a shipworm because it resembles a worm in general appearance. At the anterior end, it has a small shell/mantle with two valves which are adapted to boring into wood. Degradation of wooden components is also exacerbated by other marine organisms, such as the sheepshead (*Archosargus probatocephalus*), which destroys the already infested wood while foraging for teredo worms. Additional damage can result from stone crabs (*Menippe mercenaria*) which not only dismember wood in search of inhabiting teredo worms but will also break apart ship timbers in an effort to create a nest or den.

Human action can cause as much destruction to historic shipwrecks as the above-mentioned environmental factors. Salvage activities remove valuable (and diagnostic) machinery and structural elements. Diagnostic artifacts can be disturbed or entirely removed from their context making identification of a shipwreck much more difficult. Historical dredging and snag removal operations may destroy or remove shipwrecks from the archeological record. Wake from passing vessels, both small craft and commercial boats, can create substantial wave action to dislodge fragments of wooden-hulled wrecks. Repetitive wave action against shallow or partially exposed wrecks will rapidly accelerate their destruction. Finally, looting is a recurring problem that dramatically affects the ability of the archeologist to identify a shipwreck site. Often, diagnostic artifacts and vessel components, such as bells, anchors, rudders, or propellers, are removed by treasure seekers and souvenir hunters, thereby removing much of a vessel's identity. The above factors must be acknowledged when determining the likelihood of preservation of watercraft within the project area. The probability of preservation is high if bottom sediments buried vessels quickly. Preservation is low in areas where vessels lie exposed to the elements and human activities. Those vessels lost or abandoned near shore may have been picked clean by salvage, eroded by scouring, or damaged by repetitive exposure to boat wakes and/or wind-generated waves.

3.4 Site File and Literature Review

Prior to field investigations, a desktop review was conducted that included a state site file search. Consulting the Atlas database resulted in a listing of all recorded marine archaeological sites, shipwrecks, and National Register of Historic Places (NRHP) properties within 1.6 kilometers (1 mile) of the project APE. The site file research was used as a basis for developing a historical context and to gather information about past cultural resource survey activities near the project area. Background historical research incorporated material and data gathered during previous archaeological investigations and primary and secondary historical sources. The historical research aided in identifying potential types of marine resources that may have been deposited in the vicinity of the project area and determining the nature and extent of subsequent activities that may have removed or disturbed such resources. Data sources available for background research include historical maps, primary and secondary shipwreck lists, primary historical accounts, newspapers, NOAA's Office of Coast Survey's Automated Wreck and Obstruction Information System (AWOIS) and Electronic Navigational Charts (ENC), the THC online Atlas databases, and county and thematic histories. Information gleaned from these sources aided in developing a list of potential resources as well as identifying resources that may be expected to be located within the project area. Additionally, the TxGLO Coastal Resource Management Map was reviewed for the project area (TxGLO 2020a).

3.4.1 Previous Archaeological Investigations

Site file research revealed that no portion of the APE has ever been surveyed for submerged cultural resources; however, two marine surveys have been completed within 1.6 kilometer (1 mile) of the project area (Figure 3-6). The nearest marine survey was conducted by Coastal Environments, Inc. (Coastal) (Pearson and Simmons 1994, Texas Antiquities Code [TAC] Permit No. 1543) and is located 1.1 kilometers (0.7 miles) southeast of the APE. The second marine survey was conducted parallel to the 1994 survey in 2001 by Prewitt & Associates for the USACE (no TAC Permit No. given; Atlas No. 8500011899), with coverage overlapping the eastern portion of the 1994 corridor. The combined results of both surveys did not identify any potential cultural resources near the APE. One terrestrial archaeological reconnaissance-level survey (Atlas No. 8500001302) has been conducted within 1.6 kilometers (1 mile) of the project area.

3.4.2 Previously Recorded Cultural Resources

The review of the THC's Atlas revealed no previously recorded archaeological sites or National Register Properties within the project APE. There is one previously recorded archaeological site (41AS46) within the 1.6-kilometer (1-mile) research buffer (see Figure 3-6). Originally recorded in 1927 by Martin and Potter (Atlas No. 9007004601), Site 41AS46 consists of "a series of shell ridges and low bluffs, all subject to constant washing by the bay, with some small evidence of campsites shows in the shell and soil here, but all of it has been thrown up on the shore by the water." Site assessment presumed that an extensive site existed here, however, it has been entirely eroded away via coastal erosion (THC 2020b).

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Figure 3-6. Previous cultural resources surveys and cultural resources within 1.6 kilometers (1 mile) of the Towhead Reef project area location, Aransas Bay, Aransas County, Texas

3.4.3 Previously Recorded Shipwrecks and Obstructions

The Office of Coast Survey's AWOIS and the THC's Atlas database were consulted and revealed that there are no reported shipwrecks and one reported obstruction (AWOIS Number 6128) within the APE. While there are no reported shipwrecks within the 1.6-kilometer (1-mile) study radius of the APE, there are 20 additional reported obstructions within or partially within the study radius (Figure 3-6). The obstructions form two linear trends. The west-east trend, including AWOIS Number 6128 in the APE, are identified as route markers for a pipeline permitted to American Liberty Oil Company (Co.); the north-south trend consists of individual markers identifying the eastern margin of the GIWW. The nearest reported shipwreck (AWOIS Number 10434), an approximately 9-meter (30-foot) fishing vessel, lies approximately 3.93 kilometers (2.44 miles) west-southwest of the APE.

3.4.4 State Antiquities Landmarks and Historical Markers

The review of the Atlas revealed that there are 24 State Antiquities Landmarks in Aransas County; 20 of which are vessels. The landmarks consist of 20 vessels and four archeological sites. Review of the Atlas database also revealed that there are 56 historic markers in Aransas County. There are no State Antiquities Landmarks or Historical Markers located within 1.6 kilometers (1 mile) of the APE.

3.4.5 National Register of Historic Places

A review of the NRHP searchable online database revealed that there are five NRHP-listed properties in Aransas County, consisting of four structures and one archaeological site; and that there are no NRHP-listed properties within the 1.6-kilometer (1-mile) study radius (NRHP 2020).

4.0 FIELD METHODOLOGY

Field investigation of the project consisted of an intensive marine remote-sensing survey. The underwater survey employed a variety of geophysical technologies deployed from a survey vessel to examine the bays' beds and locate anomalies and acoustic targets on or buried in submerged sediments that might be affected by project activities. On Tuesday morning August 4, 2020, the survey crew assembled at the boat ramp in Goose Island State Park, Rockport, Texas. Located on the north side of Aransas Bay, it was conveniently located in close proximity to the survey area. The weather was relatively warm and humid. Seas were generally less than 0.3 meter (1 foot).

4.1.1 Underwater Archaeological Survey

The survey vessel used for the present project was BIO-WEST's 8.2-meter (26-foot) aluminum work vessel (Figure 4-1). The vessel's attributes (ample deck space, shallow draft, high maneuverability, davits, and winches) made it an excellent platform from which to conduct survey while towing numerous pieces of gear. The vessel was propelled by two 130 horsepower (HP) outboard motors and has a top speed of 25 knots to transit to the survey site, while a survey speed of approximately 4 to 5 knots could easily be obtained. The onboard 5-kilowatt power system provided more than enough electricity to power all the remote sensing equipment, computers, navigation gear, deck hoists and winches, and safety equipment.

Positioning is a critical aspect of marine remote sensing projects. For navigation and positional control, BIO-WEST utilized a Hemisphere® VS110 differentially corrected global positioning system (DGPS) receiver. Vessel guidance, position, and data logging were accomplished with a navigation processor utilizing Trimble® HYDROpro™ Navigation software. Positional information for the survey vessel and each instrument sensor, via layback calculations, was stored in the navigation processor at a rate of one reading per second. The navigation system was the basis around which the survey was built. Project area coordinates and pre-plotted survey lines were pre-programed into the computer. The onboard computer recorded positioning data from the DGPS in real time using the WGS84 UTM 15N US Feet coordinate system. These coordinates were then used to guide the survey vessel precisely along the predetermined survey transects, which were separated by 20-meter (65.6-foot) intervals (Figures 4-2). While surveying, vessel positions were continually updated on the computer monitor to assist the vessel operator while the processed easting and northing data were continually logged to the computer storage disk for post-processing and plotting. The survey was designed with a total of 29 primary transect lines spaced at 20-meter (65.6-foot) intervals and oriented northeast to southwest across the proposed project area.

Figure 4-1. BIO-WEST's project survey vessel.

To examine the seabed, an EdgeTech 4125 dual frequency digital side-scan sonar system was used (Figure 4-3). The dual-frequency, 400/900 kilohertz (kHz), side-scan sensor collected and gave a real time display of the acoustic data throughout survey operations.

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Figure 4-2. Planned and actual survey tracklines for the Towhead Reef project area, Aransas County, Texas.

Due to the shallow waters of the bay, the sonar towfish was deployed from the port side of the survey vessel 0.5 meters (1.6 feet) deep in conjunction with a pole mount and side bracket, in an effort to obtain the most diagnostic acoustic images of the bay bottom (Figure 4-4). The sonar unit was operated at a 75-meter (246-foot) range, which at the defined 20-meter (65.6-foot) transect interval resulted in over 300 percent overlapping coverage of the project area.

Figure 4-3. EdgeTech 4125 dual frequency side-scan sonar system.

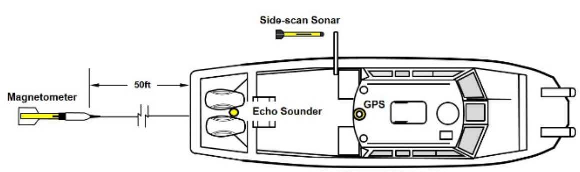

Figure 4-4. Hydrographic survey equipment layout.

Magnetic data were collected with a Geometrics G-882 Cesium marine magnetometer (Figure 4-5). Magnetometer and navigation (DGPS) data were input and recorded using HyPack Max software; a redundant magnetometer string was recorded in HydroPRO as a backup. The operating principle of the magnetometer is based on self-oscillating split-beam Cesuim vapor, with an operating range of 20,000 to 100,000 nano-tesla (nT) and a counter sensitivity of 0.004 nT. Water depth of the project area is approximately 0.9–1.8 meters (2–6 feet) deep. Due to the shallow waters of the bay, the magnetometer sensor was buoyed at the surface and towed 15.8 meters (52 feet) behind the survey vessel (see Figure 4-4).

Figure 4-5. Geometrics G-882 Marine Magnetometer with life preservers attached for towing in shallow water.

Magnetic readings were recorded at a sample rate of 1 hertz, or 1 sample per second. Magnetic "anomalies" have been defined by Garrison et al. (1989) as a deviation in the ambient magnetic field measuring 5nT (gammas) or more and recorded across three or more consecutive data samples. Enright et al. (2006) restated this definition using the same intensity criteria but using a distance measurement of 6 meters (19.7 feet) or more rather than using a predefined duration of time. Neither definition explicitly addresses water depth as a function of anomaly identification; however, both intensity and duration are relative to the separation between sensor and source. Therefore, ferromagnetic sources in extremely shallow water will produce artificially inflated intensities and durations than the same source in deeper water where there is greater distance between the source and the magnetometer (Figure 4-6). Magnetometers should not exceed a maximum altitude of 6 meters (20 feet). For the purposes of this survey, magnetic variations with a peak to peak change in intensity less than 5nT or duration of less than 6 meters (20 feet) were not mapped as "anomalies".

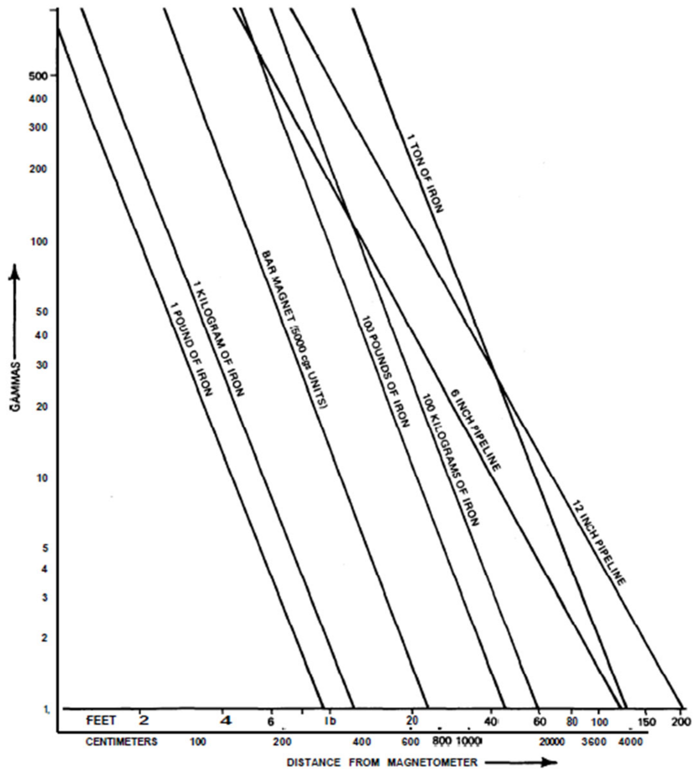

Figure 4-6. Nomogram for estimating magnetic anomalies from typical objects (assuming dipole moment M = 5×10^5 cgs/ton, i.e., k = 8 cgs) (Breiner 1999:43).

4.1.1.1 Data Products- Side-scan Sonar

The side-scan sonar derives its information from reflected acoustic energy that is recorded onto a survey computer. Side-looking sonar transmits and receives swept high frequency bandwidth signals from transducers mounted on a sensor that is towed from a survey vessel. Two sets of transducers mounted in an array along both sides of the towfish generate the short duration acoustic pulses required for high resolution images. The pulses are emitted in a thin, fan-shaped pattern that spreads downward to either side of the towfish in a plane perpendicular to its path. As the fish is towed along the survey trackline, this acoustic beam sequentially scans the bottom from a point beneath the towfish outward to each side of the trackline.

Acoustic energy emitted from the transducer travels towards the seafloor where it is reflected from the bottom sediments, and any other bottom features, such as exposed pipelines, rocks, unexploded ordnances (UXOs) or other solid submerged objects, absorbed, or scattered. The acoustic energy reflected back towards the towfish is received by the transducers, amplified, and transmitted to the survey computer via a towed data cable. The digital output illustrates in graphic form the speed and strength of the returned acoustic energy, providing detailed representations of bottom features and characteristics. Sonar allows the display of positive relief (features extending above the bottom) and negative relief (such as depressions) in either light or dark opposing contrast modes on a video monitor. Additionally, the reflectivity of bottom sediments can indicate transitions between harder and softer seabed materials. Examination of the images thus allows a determination of significant features and objects present on the bottom within a survey area.

Acoustic targets are normally defined according to their spatial extent, configuration, location, and environmental context. Characteristics of an acoustic target to be scrutinized in a sonar image are spatial extent, association or configuration, location, and the environmental context. Shipwrecks are generally easy to discern as are other large, regular, articulated cultural features. Additionally, many natural features, such as rock outcrops, oyster reefs, sunken logs, and even schooling fish create reflections that can be identified in the data. It can be difficult to discern natural from anthropogenic features within the data.

Sonar data were recorded digitally in the field using Edgetech's Discover software and processed using SonarWiz Ver 7.06.04. Following import, the data were bottom tracked, and TVG/gains adjusted for optimal display. Offsets were confirmed to adjust for the distances between the sensor and navigation antenna. Sonar targets were interpreted line by line, and then rationalized; only those features observed on multiple lines within overlapping coverage were interpreted as seafloor targets. A sonar mosaic was generated from the processed data and exported in geotiff format.

4.1.1.2 Data Products-Magnetometer

The Geometrics G-882 Marine Magnetometer measures the earth's ambient magnetic field strength at the sensor's location. Although the earth's magnetic field does change with both time and distance, over short periods and distances the earth's field can be viewed as relatively constant. The presence of magnetic material and/or magnetic minerals, however, can add to or subtract from the earth's magnetic field creating a localized magnetic anomaly. Rapid changes in total magnetic field intensity, which are not associated with normal background fluctuations, mark the locations of these anomalies.

Magnetometer data were interpreted using HyPack, with individual anomalies picked line by line. Background noise was confined to +/- 1nT. The overall ambient field increased northward by approximately 16nT; however, this did not obscure the ability to identify individual anomalies within the overall ambient trends. Magnetometer data used in contouring were corrected for diurnal variation using IAGA2000 formatted data from Observation Station BSL operated by the USGS. The ambient magnetic field was not removed from the diurnally corrected data, as this negated the ability to identify smaller duration point source anomalies within the data set. The diurnally corrected ambient data were then gridded in Surfer using the natural neighbor algorithm to reduce data exaggeration within non-normal polygons along the perimeter of the project area. The final contours were exported at 5nT intervals to illustrate the picked anomalies.

4.1.2 Remote Sensing Interpretation-Magnetometer

The magnetometer and side-scan sonar are the basic tools of marine archaeology. The magnetometer can indicate metal objects, which are some of the main components of shipwrecks, while the side scan can create an image of the seabed that allows for a detailed analysis of recorded objects. Unfortunately, the analysis and interpretation of remote sensing data is a process that is not 100 percent accurate in identifying a target's source. While a physical examination is the only way to positively identify the source of a remote sensing target, in most cases, it is not economically feasible to examine every recorded anomaly. Therefore, a rational method has to be used to discriminate the likelihood that a magnetic anomaly source or side-scan sonar image represents a potentially significant cultural resource. Numerous factors should be considered while interpreting remote sensing data.

The factors that make up the basis for remote sensing interpretation are just as important as quality data acquisition. Magnetometer data present several properties which can be used for analysis. One characteristic examined is magnetic amplitude, or the deviation recorded from background readings. The change from background may be either positive or negative or both. If the amplitude change is only in a single direction it is known as a monopole, if it has a single positive and negative change it is a dipole. If the anomaly source has more than two opposing peaks, it is complex. Another significant characteristic for analysis is the anomaly's duration and how long it occurs in the record. Again, an anomaly is a local event and the closer the sensor is to its source the greater the amplitude recorded (see Figure 4-6). Within this local field, the recorded duration will change from and return to ambient background readings where it is no longer detected by the sensor. Another attribute of an anomaly that has been receiving more attention in analysis lately is its orientation, the way the poles of the anomaly are oriented relative to the earth's magnetic field. Magnetic deviation recorded is, in part, a function of distance between the sensor and magnetic source material, for example, the closer the sensor to the material, the larger the reading.

Effective analysis of magnetic remote sensing data depends on quality data collection, knowledge of the environment from which the data are collected, and experience with examining anomaly sources. Through the years, several authors have created models to aid in interpreting remote sensing data, especially magnetometer data. Garrison et al. (1989) created an early model based on selected shipwrecks in the Northern Gulf of Mexico. The authors suggest that "a shipwreck as an archaeomagnetic feature can be defined as a cluster of multiple anomalies within an area of 50,000 sq m or less" (Garrison et al. 1989: Vol II, 222). They further state that "isolated anomalies over a large spatial area with little or no expression on adjacent survey lines of reasonable width will, in most instances, be marine debris" (Garrison et al. 1989: Vol II, 222). The authors do warn that both statements are generalizations and cite the magnetic signature of a coil of cable, modern debris, as mimicking their expected pattern for a historic shipwreck. The authors conclude by providing eight criteria for characterizing historic shipwrecks from sonar and magnetometer data. Those criteria specific to magnetometer data include multiple peak anomalies, varying amplitudes, areal distribution of anomalies over greater than 10,000 square meters (107,639 square feet), axial or linear orientation of anomalies, and long durations (Garrison et al. 1989:Vol II, 223).

Later, Pearson et al. (1991), considering the earlier work, developed a new model in order to suggest the presence of shipwrecks based on observed magnetic amplitude and duration of a known sample of shipwreck sites. Threshold data for potential shipwreck sites were set at 50-gamma total magnetic deflection from background with a linear duration of greater than 24 meters (80 feet). Recently, Linden and Person, "recognizing a considerable amount of variability," have revised Pearson's initial quantitative measurements downward to eliminate targets with magnetic signatures of 50-gamma deflection and less than 20-meter (65.6-foot) duration (Linden and Pearson 2014). In addition to these quantitative limits, Pearson with Hudson (1990) have argued for a qualitative assessment of remote sensing data as well. The environmental context in which an anomaly is located is an important factor in its analysis and interpretation.

The present project area environment consists of a relatively shallow area within Texas' Aransas Bay. Maritime activity, within the GIWW, which is located southeast of the survey area, allows access to and through the interconnected bays. Besides commercial vessels transiting the areas, recreational vessels are also common in the bays. Additionally, the survey area is noted to be in the general vicinity of natural gas and oil development areas; AWOIS records indicate markers related to a permitted pipeline extend across the project area. A review of the Railroad Commission of Texas Public Geographic Information System (GIS) Viewer revealed that there are no records of existing pipelines or natural gas and/or oil wells within the project area; the closest known wellhead is located 0.7 kilometers (0.4 miles) to the west (Railroad Commission of Texas 2020). These environmental and cultural factors including debris deposition, various seabed/shoreline modifying activities such as channel construction and other navigation projects, or obvious commercial fishing may contribute to the archaeological record and should be taken into consideration while conducting an analysis of the project anomaly data.

A third model does not rely exclusively on a specific magnetic deflection or area of coverage but on the very essence of the earth's magnetic field and the orientation characteristics of a recorded magnetic anomaly. In order to increase the efficiency of magnetic analysis as, "Only a tiny fraction of seafloor magnetic anomalies are associated with shipwrecks," Gearhart (2011:91) has created a model for identifying shipwreck sites based, in part, on the principles of magnetic orientation. Using 29 known shipwreck sites comprising a varied selection of vessel types exhibiting a wide range of horizontal dimensions and magnetic amplitudes, the basis of other magnetic interpretive models, Gearhart highlights the orientation of the represented anomaly itself, an overall dipole configuration. One unique magnetic characteristic of all known shipwrecks in the sample presented is the magnetic orientation of the anomaly over all shipwreck sites, the negative component of a dipolar anomaly unfailingly resides to the geographic north. Additionally, it is recognized that the magnetic deviation of the graphically represented signature did not vary greater than 26 degrees from magnetic north (Gearhart 2011). Thus, a dipolar anomaly with a positive gamma deflection to the north is not consistent with known shipwreck sites and therefore should not be considered a potential shipwreck. The smallest shipwreck located by this method is known as Site 41CL92. The magnetic anomaly for this site had a total magnetic deviation of 191 gamma made up of a positive and negative component and could be detected over an area of 1,580 square meters (0.4 acres) at a 5-gamma interval. The site, when examined by divers, measured roughly 7 by 16 meters (23 by 52 feet) and is thought to be the remains of a nineteenth-century sailing vessel (Gearhart 2011).

A study in a context very different from the present research, Boston Harbor, examined 67 previously identified remote sensing targets. The historic importance of the water body to American history cannot be discounted. The examination found approximately 15 percent of the initially identified anomalies were mobilized following data acquisition and could not be relocated during subsequent survey; the sources for the remaining targets were identified. The materials examined spanned the gamut from metal debris, pipes, and chain to modern fishing gear and several watercraft. Four barges, one modern vessel, and the remains of a potentially significant wooden hulled shipwreck were observed. In the context of a harbor that has had centuries of historic traffic and is still actively used today, only one potentially historic site was located (Tuttle 2004). Locating one potentially significant site indicates the rarity and difficulty of distinguishing remote sensing data as significant archaeological sites. However, it also indicates the necessity to examine anomalies in the proper context to ensure that the rare sites that are indicated in the record are protected.

Interpreting the context of an archaeologically surveyed area relative to remote sensing analysis is the grayest of the evaluation criteria. There are no baseline numbers or qualitative assessments to be referred to or consulted. Experience and in some respects common sense are required to make a subjective evaluation based upon the variables pertaining to the environment worked in. The only way to know the source of every magnetic anomaly or side-scan image is to have a complete examination either by an archaeological diver or remotely operated vehicle. "Hands-on inspection of every buried anomaly source may not be an economic possibility, so researchers must trust their interpretive abilities" (Gearhart 2011). In the context of the present research, the environmental and historic considerations will be one of the factors considered while interpreting for potential significance of the sources of magnetic anomalies.

The present investigation in the shallow waters of Aransas Bay uses the above-mentioned methods to filter anomalies to determine potential significance as a necessity, as every anomaly is not a shipwreck. The main filters employed are those developed by Linden and Pearson (2014), Garrison et al. (1989), and Gearhart (2011). Anomalies interpreted as monopoles, or diploes with a positive magnetic deflection to magnetic north, were not considered potentially significant and thus removed from consideration of potential significance. Small single point sources were not considered significant either.

5.0 RESULTS OF INVESTIGATIONS

Survey operations were conducted on August 4, 2020 using a pole-mounted Edgetech 4125 dual frequency side-scan sonar system operating at 400 and 900 kHz, a pole-mounted Odom singlebeam echosounder, and a towed Geometrics G-882 total field magnetometer. The magnetometer was deployed behind the boat and buoyed at the surface, with sufficient cable out to avoid interference from the vessel or its outboard engines. Sensors were deployed during reconnaissance lines and tuned for optimal data quality prior to the start of survey acquisition. Sonar data were acquired using Discover software; magnetometer and fathometer data were integrated into both HyPack MAX and Trimble's HydroPro navigation software package, which also provided real-time vessel positioning and horizontal control.

The survey was designed with a total of 29 primary transect lines spaced at 20-meter (65.6 foot) intervals and oriented northeast to southwest across the proposed project area. The Towhead Reef project area was selected by TPWD because it is the site of a naturally occurring oyster reef that has degraded over time. During survey operations, the vessel encountered extremely shallow water across the top of the degraded reef that prohibited data collection. The survey line plan was amended in the field so that the planned survey lines were bisected, with regularly numbered line segments run in the northern two-thirds of the project area, above the reef. The southern portion of each line was resumed south of the reef and continued to the southern limit of the survey area. The average distance between the end of the northern lines and start of the southern line segments was approximately 107 meters (350 feet). To provide supplemental coverage, four perpendicular lines were added in the field, two on the north side of the reef and two on the south side of the reef; the average distance between the added transects was approximately 25 meters (82 feet). Distance between transects varied due to water depths. The amended survey plan provided as much coverage as could safely be obtained, and without causing accidental damage to the extant reef structure. The combined data were analyzed to determine any existing hazards/obstructions on or below the seabed and document any magnetic anomalies that could present historic shipwrecks for avoidance during project activities.

5.1 Bathymetry Data

Recorded water depths in the Towhead Reef area range from a minimum of 0.6 meters (2 feet) below sea level (bsl) to a maximum of 1.8 meters (6 feet) bsl in the project area (Figure 5-1). The ambient seafloor depth is approximately 1.8 meters (6 feet); three distinct areas of shallow depth are apparent in the recorded contours. The first correlates with the relict oyster reef in the southern third of the project area; this is the reef feature that caused the line plan to be amended in the field. The two other areas correlate with charted shallows (NOAA 11314) and areas of increased seafloor reflectivity likely indicative of additional reef features. No bathymetric irregularities were observed that suggested buried archaeological features.

5.2 Side-Scan Sonar Data

Side-scan sonar data were acquired at 75-meter (246-feet) range, resulting in greater than 300 percent coverage of the project area. The sonar mosaic was trimmed to the innermost 30 meters (98 feet) per channel for geotif production.

The sonar data depict a generally moderately to strongly reflective seafloor across the project area that is interrupted by a single linear trend of significantly decreased reflectivity (Figure 5-2). A total of three targets were recorded from the sonar data. Sonar target number (no.) 1 is in the north central portion of the project area.

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Figure 5-1. Bathymetric contour map of the Towhead Reef area, Aransas County, Texas, at 0.3 meter (1-foot) intervals.

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Figure 5-2. Side-scan sonar mosaic of the Towhead Reef area with sonar targets, Aransas County, Texas.

The target is an irregularly shaped feature measuring approximately 1.1 meters x 1.1 meters (3.5 feet x 3.5 feet) with a maximum calculated height above the seafloor of 0.2 meters (0.6 feet). Sonar target no. 2 is in the east-central portion of the project area and is also within the linear trend of weakly reflecting sediment. The target is an irregularly shaped feature measuring approximately 0.8 meters x 0.9 meters (2.7 feet x 3.0 feet) with a maximum calculated height above the seafloor of 0.4 meters (1.2 feet). Sonar target no. 3 is in the southeastern corner of the project area. The target is an irregularly shaped feature measuring approximately 0.8 meters x 0.8 meters (2.7 feet x 2.5 feet) with a maximum calculated height above the seafloor of 0.3 meters (0.9 feet). All three targets are interpreted as probable crab traps; multiple Styrofoam buoys were observed in the project area during survey and are often associated with recreational fishing traps. All three targets also have an approximately rectangular shape, with increased reflectivity above the surrounding sediments.

All of the interpreted sonar targets are shown on the sonar mosaic (Figure 5-2) and detailed in Appendix B.

5.2.1 Magnetometer Data

Digital magnetometer data were interpreted line by line in HyPack for anomalies as previously defined in Chapter 4. Magnetometer data recorded a total of 52 unidentified anomalies within the Towhead Reef area, of which 6 exceeded the intensity (50nT) and duration (20-meter [65.6-foot]) criteria defined by Linden and Pearson (2014) for anomalies representative of potential cultural resources (Figure 5-3). These anomalies, including nos. 1, 2, 12, 14, 23, and 29, were then scrutinized using the criteria for historic shipwrecks defined by Garrison et al. (1989) and Gearhart (2011) and are discussed in greater detail below.

- Anomaly No. 1 is a positive monopolar anomaly that corresponds with Anomaly No. 35 on the adjacent transect to the north, which is a negative monopole. Although the contours appear to represent spatially isolated anomalies, together they represent a possible dipolar contour with the negative lobe oriented almost due north. There are no other anomalies within a 90-meter (300-foot) radius. Anomaly No. 1 does not correlate with any features that are recorded from either bathymetry or sonar data and likely represented a buried feature. Due to the anomaly's characteristics, association with Anomaly No. 35, and northward negative lobe consistent with the Gearhart (2011) model, it is interpreted as a possible cultural resource. It should be avoided by a distance of 50 meters (164 feet); this radius will encompass Anomaly No. 35 (Figures 5-3 and 5-4).

- Anomaly No. 2 is spatially isolated and on the outer margin of the survey area; the lack of surrounding data minimizes the contoured appearance of the anomaly, which appears in profile as a positive monopolar anomaly. Anomaly No. 2 is loosely correlated with Anomaly No. 43 which is a negative monopolar feature that does not connect to Anomaly No. 2 and is oriented to the northwest. Anomaly No. 2 is interpreted as probable modern debris.

- Anomaly No. 12 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The anomaly is a positive monopolar feature and is interpreted as probable modern debris.

- Anomaly No. 14 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The anomaly is a dipolar feature on the northern margin of the project area that largely contours negative. Given the lack of associated anomalies, it is interpreted as probable modern debris.

- Anomaly No. 23 is spatially isolated, with no correlating anomalies observed from the adjacent lines. The anomaly is a positive monopolar feature and is interpreted as probable modern debris.

- Anomaly No. 29 is a dipolar anomaly that contours with two distinct negative lobes oriented towards the east-northeast and two corresponding positive lobes to the west-southwest. A separate, distinct anomaly (No. 10) is located on the same survey transect just to the north of Anomaly No. 29. The contours associated with Anomaly No. 29 correlate with the charted position of submerged piles as shown on NOAA Chart 11314. Anomaly No. 29 is interpreted as probable modern debris.

The magnetic contours are plotted in 5nT intervals (Figure 5-4). All of the interpreted magnetic anomalies are tabulated in Appendix C.

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Figure 5-3. Magnetic anomalies interpreted within the Towhead Reef area, Aransas County, Texas.

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Figure 5-4. Magnetic contours within the Towhead Reef area, Aransas County, Texas in 5nT intervals.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Under contract to TPWD, Gray & Pape conducted a submerged cultural resources remote sensing survey for the proposed 74.9-hectare (185-acre) Towhead Reef Project APE within Aransas Bay. The marine archaeological survey was undertaken to evaluate the bay bottom to determine if any potential significant cultural resources are present within the APE and provide recommendations for any such potential cultural resources. The purpose for the project was to assist the TPWD in complying with Federal statues including Section 106 of the National Historic Preservation Act of 1966, as amended, the regulations of the Advisory Council of Historic Preservation (30 CFR Part 800), the NHPA of 1969, as amended; as well as the Antiquities Code of Texas [Title 9, Chapter 191 of the Texas Natural Resources Code] and the Texas Administrative Code [Title 13, part 2, Chapters 26 and 28]).

A review of the Texas Archeological Atlas indicated that there are no previously conducted cultural resources surveys, previously recorded cultural resources, or previously recorded shipwreck sites located within the project area. The literature review did show that three previous cultural resources surveys, consisting of two marine surveys and one terrestrial reconnaissance-level shoreline survey, have been conducted within a 1.6-kilometer (1-mile) radius of the current APE. Research also revealed that there is one archeological site (41AS46) located within 1.6 kilometers (1 mile) of the APE. The review of the AWOIS and ENC data indicates that there is one reported obstruction and no reported shipwrecks within the current APE (Figure 5-1). The review of the database shows that there are 20 additional reported obstructions, but no shipwrecks within 1.6 kilometers (1 mile) of the APE.

The marine archaeological fieldwork was conducted on August 4, 2020 and consisted of a comprehensive remote sensing survey within the APE utilizing magnetic and acoustic profiling devices correlated with DGPS. The predetermined grid for the remote sensing survey within the open waters of Aransas Bay consisted of a total of 29 track lines (Lines 1–29) at 20-meter (65.6-foot) line spacing. The comprehensive analysis of the magnetic data recorded in the Towhead Reef Project survey area resulted in the identification of a total of 52 magnetic anomalies. Of the interpreted magnetic anomalies, one (Anomaly No. 1) exhibits the combined magnetic criteria as defined by Linden and Pearson (2014), Garrison et al. (1989), and Gearhart (2011) indicative of potential cultural resources (i.e. historic shipwrecks).

Anomaly No. 1, interpreted as a potential cultural resource, will require a 50-meter (164-foot) avoidance areas, as mandated by Texas Administrative Code, Title 13, Part 2, Chapter 26. The remaining anomalies (Nos. 2–52) are interpreted as modern debris associated with recreational and commercial fishing activities, and miscellaneous debris from previous tropical storms as well as existing pipelines, submerged piles, and marker piles.

Side-scan sonar imagery did not indicate any potentially significant cultural material laying above or on the bay bed within survey area. It did however distinguish between the harder and softer sediments and indicated three separate areas of probable degraded reef, as well as a linear trend of weakly reflective sediment possibly indicative of a trench scar or other seafloor disturbance related to infrastructure. Three sonar targets were recorded in the project area, all of which are interpreted as probable traps associated with recreational fishing activities.

The recommended management action for the Towhead APE is avoidance of bottom disturbance activities within the 50-meter (164-foot) avoidance area, as mandated by Texas Administrative Code, Title 13, Part 2, Chapter

26, for magnetic Anomaly No. 1. If avoidance is not possible, then Gray & Pape recommends archaeological diver-ground truthing to identify and evaluate the NRHP significance of the magnetic anomaly. No further archaeological investigations are recommended for Anomalies No. 2–52.

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APPENDIX A: SONAR TARGET TABLE

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APPENDIX B: SONAR TARGET IMAGES

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APPENDIX C: MAGNETIC ANOMALY TABLE

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